A Re-processed SHADOZ (Southern Hemisphere ADditional OZonesondes) Dataset: Impact on Agreement with Satellites

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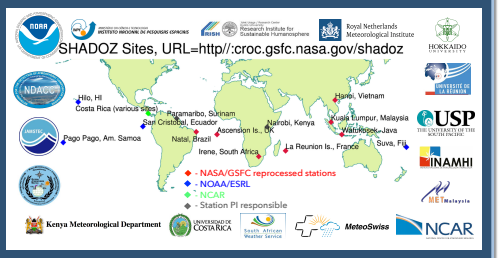
SHADOZ is a NASA project in collaboration with US and international partners to archive profile from ozonesondes in tropical environments and remote, value-added locations in the southern hemisphere. Profiles are publicly available at http://croc.gsfc.nasa.gov/shadoz.

Rationale

- Like many long-term sounding stations, SHADOZ is characterized by variations in operating procedures, launch protocols, and data processing such that biases within a single site data record and among sites appear.
- Over time, the ozonesonde instrumentation and data processing protocols have changed, adding to the measurement uncertainties at individual stations and limiting the reliability of ozone profile trends and continuous satellite validation.
- Currently, the ozonesonde community is engaged in reprocessing ECC data, with an emphasis on reprocessing long term records to compensate for the variations in instrumentation and technique.



Goal

- To improve the information and integrity of each SHADOZ measurement record by correcting known errors based on post-processing guidelines.

REPROCESSING APPROACH

NASA/GSFC has reprocessed seven stations (red diamond on SHADOZ map)
Natal, Brazil
Ascension, U.K.
Irene, South Africa (analysis shown below left)
La Reunion, France
Kuala Lumpur, Malaysia (analysis below right)
Hanoi, Vietnam (in preparation)

Reprocessing is based on:

1. Coaching by ozonesonde NOAA/ESRL/GMD experts (Bryan Johnson, Chance Sterling, Patrick Cullis, and Allen Jordan) using the SkySonde Post-processing tool developed by Allen Jordan (CIRES@NOAA/ESRL).
2. Post-processing guidelines follow: WMO report #201, Quality Assurance and Quality Control for ozonesonde measurements and SI2N/O3S-DQA Activity Homogenization Guidelines.

Primary source materials

SUMMARY

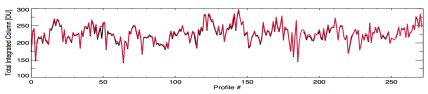
Factors contributing to differences between reprocessed and original data records vary station to station. Limitations to complete reprocessing are due to a combination of:

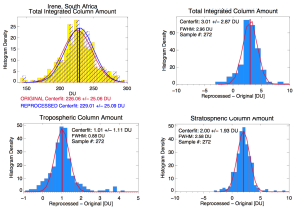
- Unavailable metadata information (for example Lab conditions to calculate the flowrate correction).
- Instrument version, i.e. historic RS80 radiosondes lacking GPS information dominate SHADOZ data records prior to the mid-2000s.
- Changes in software and systems over the course of the data record. Discontinuities due to varying radiosonde types, i.e. Vaisala or Modem, have yet to be characterized.
- Software incompatibilities, i.e., some records are missing pump temperature – a key variable in calculating ozone.

Reprocessed Irene, South Africa

Table of station metadata information and reprocessing approach.
Irene Station PI: Gert JR Coetsee (SAWS, S. Africa)

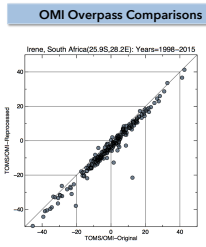
	Type	Timeline	Correction
Solution	1% Full Buffer	Entire record	
Solution volume	2.5 cc	Entire record	α (absorption efficiency) = $1.0044 \cdot 4.4 \times 10^{-5} (P_{hPa})$; $100 < P_{hPa} < 1050$ hPa
Instrument	SPC	Entire record	
Background Current	IB2 used	Entire record	IB ≤ 0.05 uA, ΔIB=0.02 uA IB > 0.05 uA, ΔIB=0.04 uA
PCF	4AKOMHYR1986	Entire record	No correction
Flowrate correction	Non applied	Entire record	Use: T<25CsS, RH<50%±25, P<850hPa 1.86%, $\Delta C_{PC} = 0.005$
Pump Temperature	RS80 – missing Tpump	1998-2006/06/21	Use monthly climatology constructed from Samoa, Hilo, and Nairobi. Include 1-sigma uncertainty.
	RS92	2006/10/25 - present	No correction
Pressure offset	RS80	1998-2006/06/21	No Correction – Vaisala system used with GS2S ground check for PTU offsets.
	RS92	2006/10/25 – present	No correction – GPS included along with ground check for PTU offsets.

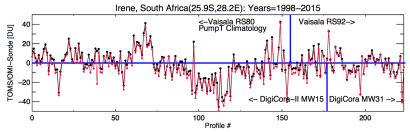


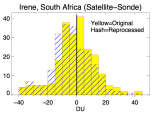


- Reprocessing results in an overall increase in ozone throughout the profiles compared to the original data records. Centerfit= +3.0DU in Total Integrated Column.

OMI Overpass Comparisons

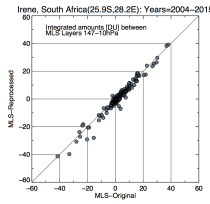


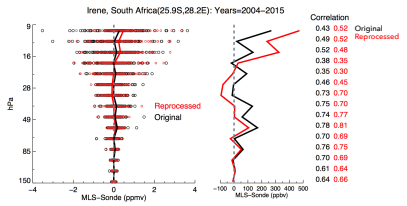




- Increases in the reprocessed Irene ozone results in a shift in agreement with OMI_{Irene} by 3.0 DU. This increases the overall OMI_{Irene} low-bias relative to Irene reprocessed data record.
- Reprocessing does **not** resolve differences due to changes in software or radiosonde type and manufacturer which may explain some of the OMI_{Irene} vs $Sonde_{Irene}$ discrepancies seen above.

MLS Overpass Comparisons



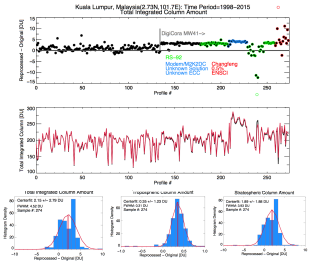


- Although integrated column amounts between MLS_{Irene} and reprocessed $Sonde_{Irene}$ are observed to be small, profile comparisons show a cancellation effect where MLS_{Irene} < $Sonde_{Irene}$ below ~16 hPa and MLS_{Irene} > $Sonde_{Irene}$ above 16 hPa (red profile above).
- Correlations are slightly improved for reprocessed $Sonde_{Irene}$ above 16 hPa as outliers in the original data record are either removed or corrected during reprocessing.

Reprocessed Kuala Lumpur, Malaysia

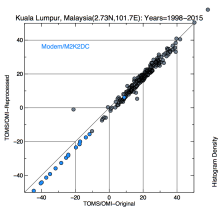
Table of station metadata information and reprocessing approach.
Station PI: Maznorizan Mohamad (MMD, Malaysia)

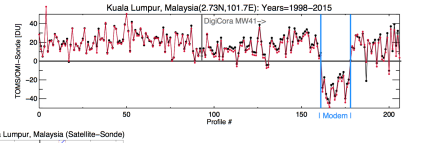
	Type	Timeline	Correction
Solution	1% Full Buffer	2003-2014/10/28	
	0.5% Half Buffer	2015/12/08 – present	
Solution Vol	3 cc		
Instrument	SPC	2003-2014/10/28	Non
	ENSCI	2015/12/08 - present	Non
Background Current	IB2 used	Entire record	IB ≤ 0.05 uA, ΔIB=0.02 uA IB > 0.05 uA, ΔIB=0.04 uA
	Missing IB2	172 records 1998-2010	Use IB=0.03 uA based on Gaussian centerfit for SPC6A 1% full buffer
PCF	Unknown		SPC: 4AKOMHYR1986 ENSCI: SATBMT
Flowrate Correction	Not applied	2003-2015/01/12	Use: T<25CsS, RH<50%±25, P<1010hPa 1.57%, $\Delta C_{PC} = 0.004$
	Missing values	172 records 1998-2010	Back-calculate based on O3 eqn.
Pump Temperature	Lab PTU available	2015/02/09 – present	Non
	RS80, RS92, Modem, ChangFeng		Internal Tpump – no correction
Pressure offset	Missing RS80 Tpump	Various records 1998-2005	Use monthly RS80 climatology
	RS80	2003 – 2010/02/17	No GPS – no agreement on pressure bias
	Modem	2010/03/01 – 2011/12/17	No correction – no GPS information
	RS92	2012/02/20 – 2014/10/28	Correct to GPS
	ChangFeng	2015/12/08 – present	No correction – no GPS information

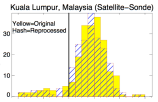


- Reprocessing results in overall small increases in Kuala Lumpur ozone when compared to the original data record.
- Observed discontinuities coincide with changes in radiosonde type and system, and software updates, which are not addressed in the ECC reprocessing guidelines.
- A jump in $Sonde_{KL}$ total column amounts coincide with a short period of Modem Radiosonde/System use in 2010/2011.

OMI Overpass Comparisons

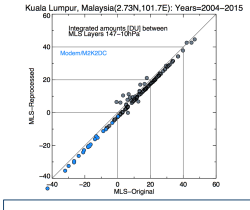


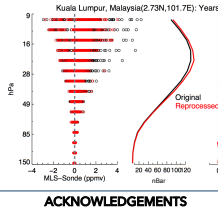


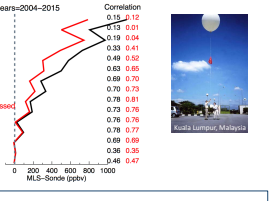


- The period where $Sonde_{KL}$ significantly deviates from OMI_{KL} and MLS_{KL} coincides with the use of the Modem Radiosonde and System (blue circles).
- Improved agreement is observed between MLS_{KL} and reprocessed $Sonde_{KL}$ throughout the profiles (red profile below).

MLS Overpass Comparisons







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